

HOST-PLANT RELATIONS OF NATIVE *UROPHORA* SPP.
(DIPTERA: TEPHRITIDAE) IN SOUTHERN CALIFORNIA

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Abstract.—New (some initial) host-plant records are reported for *Urophora caurina* (Doane), *U. formosa* (Coquillett), *U. rufipes* (Curran), *U. stenoparia* Steyskal, and *U. timberlakei* Blanc and Foote. *Urophora rufipes* is initially reported from California. The host plants of these tephritids include one or more species of *Acamptopappus*, *Chrysothamnus*, *Grindelia*, *Gutierrezia*, and *Haplopappus*, all noted to belong to the Subtribe Solidagininae of the Tribe Astereae of the Asteraceae. Synphagy among *Urophora*, *Neaspilota*, *Procecidochares*, *Tephritis*, and *Trupanea* species is documented and discussed.

This is a companion paper to one to be written by G. C. Steyskal (retired), Systematic Entomology Laboratory, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C., who will treat the taxonomy of some of the specimens reported herein. I report here new information on the host-plant relations of several native *Urophora* spp. (Diptera: Tephritidae) resulting from the past six years of field studies on nonfrugivorous fruit flies in southern California, that section of the state defined and treated botanically by Munz (1974).

MATERIALS AND METHODS

The materials and methods used in the sampling of mature flower heads of Asteraceae and the rearing of Tephritidae from samples were described by Goeden (1985). Sweep net collections of adults limitedly supplemented these rearings. Identifications of most flies mentioned in this report were confirmed or made by G. C. Steyskal. All host-plant identifications were confirmed or made by Andrew C. Saunders, Curator of the Herbarium of the University of California, Riverside. The plant nomen-

clature used is that of Munz and Keck (1959) and Munz (1974); the insect nomenclature, that of Steyskal (1979).

RESULTS AND DISCUSSION

Steyskal (1979) reviewed what little was known about the host plants of native North American species of *Urophora*. Except for the atypical species, *U. acuticornis* Steyskal reared from *Lycium berlandieri* Dunal (Solanaceae), all known host plants of Neotropical *Urophora* are Asteraceae. Unlike the Palearctic *Urophora*, no North American *Urophora* has been reported from asteroceous thistles. At least four Palearctic species have been introduced from Europe to Canada and the United States for the biological control of accidentally introduced, weedy thistles in the genera *Carduus*, *Centaurea*, and *Cirsium* (Steyskal, 1979; Julien, 1982). So far, no European species of *Urophora* has successfully been established in California for thistle control (Julien, 1982). Moreover, recent surveys of insects infesting the flower heads of native *Cirsium* thistles in northern California (Pemberton et al., 1985) and the above-ground shoots (including heads) in southern California (Goeden and Ricker,

1986b, 1987a, b) yielded no rearing records of native *Urophora*. It may be as Steyskal (1979, p. 25) has suggested, that "... the American species of *Urophora*, at least in part, may eventually be referred to other genera inasmuch as none of them seem to be very closely related to any Palearctic species, ..." I offer the following information on host-plant relations of native *Urophora* in southern California as a contribution to a better understanding of the biology and ecology of the genus. The following treatment of flies is alphabetical by species.

Urophora caurina (Doane).—Steyskal (1979) listed the host of *U. caurina* as the genus *Grindelia*. I never reared this species from a total of 13 samples of flower heads of five species of *Grindelia* that I have sampled since 1980. However, 2 ♂ of *U. caurina* were reared from a quantity of flower heads of *Gutierrezia sarothrae* (Pursh) Britton and Rusby collected in the Chihuahu Valley, NE San Diego Co., 11.xi.1982. Also, 8 ♂ and 8 ♀ of *U. caurina* were reared from a quantity of flower heads of *Haplopappus ericoides* (Lessing) Hooker and Arnott ssp. *blakei* C. B. Wolf collected near Orcutt, Santa Barbara Co., 12.xi.1980. Both records represent new host-plant genera for this tephritid.

Urophora formosa (Coquillett).—Wasbauer (1972) listed *Chrysothamnus viscidiflorus* (Hooker) Nuttall, *Grindelia camporum* Greene, *G. nana* Nuttall, *Grindelia* sp., *Haplopappus squarrosus* Hooker and Arnott ssp. *grindelioides* (deCandolle) Keck, and *H. venetus* (Humboldt) Blake as hosts of *U. formosa*. In reviewing these host genera, Steyskal (1979) noted that some of these records may properly refer to *U. caurina*. I have reared the following specimens of *U. formosa*: 9 ♂ and 11 ♀ from flower heads of *H. squarrosus* spp. *grindelioides* collected above upper end of Kitchen Creek, Cleveland Nat. Forest, San Diego Co., 9.ix.1980; 7 ♂ and 7 ♀ from flower heads of *H. venetus* prob. spp. *furfuraceus* (Greene) Hall col-

lected in Proctor Valley, SW San Diego Co., 28.x.1981; 15 ♂ and 11 ♀ reared from flower heads of *H. venetus* spp. *vernonioides* (Nuttall) Hall collected NW of Temecula, SW Riverside Co., 15.x.1980; 1 ♂ and 5 ♀ reared from flower heads of *H. venetus* prob. spp. *vernonioides* collected at Cardiff-by-the-Sea, San Diego Co., 15.x.1980; 12 ♂ and 16 ♀ reared from a quantity of flower heads of *H. venetus* spp. *vernonioides* collected near U.S. Navy facility on Santa Cruz Island, Santa Barbara Co., 8.x.1985. My rearing records definitely confirm *Haplopappus* as hosts of *U. formosa*; however, as with *U. caurina*, I have not reared *U. formosa* from any sample of *Grindelia* to date (including a sample of *G. camporum*). As the host records for *U. formosa* from *Grindelia* in Wasbauer (1972) are based on two or three separate plant species and three independent sources and F. L. Blanc (in litt. 1986) has reconfirmed the record for *G. camporum* in Foote and Blanc (1963), this suggests a definite relationship under as yet undefined conditions with this fly. This host-plant relationship warrants additional study. The published "unpublished" host record for *C. viscidiflorus* in Wasbauer (1972) remains unconfirmed. It may properly refer to a sweep record or, perhaps, to *U. timberlakei* Blanc and Foote (see discussion below).

Urophora n. sp. Steyskal.—To complicate matters further, the only tephritid that I have reared from *Grindelia* to date in southern California apparently is undescribed (Steyskal, in litt. 1986). The sole host plant found to date for the robust individuals of this species appears to be *G. hallii* Steyermark, a plant species confined to dry flats in the Cuyamaca Mountains, San Diego Co. (Munz, 1974), and especially common around Lake Cuyamaca, where mature flower heads sampled in quantity on 9.ix.1980 and 17.vii.1985 yielded only 2 ♂ and 4 ♀ and 2 ♂ and 1 ♀, respectively. Flower heads sampled in bulk on 2.vii, 31.vii, and 14.viii.1985 from the same area yielded no flies. Factors involved in oviposition site

Table 1. Synphagy among Tephritidae reared with *Urophora* from samples of mature heads of Asteraceae from southern California 1980–1985.

Host Plant ^a	Sample Date ^a	Tephritid Genera (No. Species) Reared	Total No. (%) Adults Reared
<i>Acamptopappus shockleyi</i>	27 V 1982	<i>Neaspilota</i>	13 (11)
		<i>Trupanea</i> (2)	71 (58), 21 (17)
		<i>Urophora</i>	17 (14)
<i>A. sphaerocephalus</i>	21 V 1982	<i>Neaspilota</i>	3 (11)
		<i>Trupanea</i>	20 (71), 2 (7)
		<i>Urophora</i>	3 (11)
<i>Chrysothamnus nauseosus</i>	3 IX 1982	<i>Neaspilota</i>	1 (6)
		<i>Procecidochares</i>	3 (18)
		<i>Tephritis</i>	6 (35)
		<i>Trupanea</i> (2)	4 (24), 2 (12)
		<i>Urophora</i>	1 (6)
<i>C. viscidiflorus</i>	3 IX 1981	<i>Trupanea</i>	7 (9)
		<i>Urophora</i>	73 (91)
		<i>Urophora</i>	6 (100)
<i>Grindelia hallii</i>	9 IX 1981	<i>Urophora</i>	6 (100)
	17 VIII 1985	<i>Urophora</i>	6 (100)
<i>Gutierrezia microcephala</i>	9 IX 1981	<i>Urophora</i>	4 (100)
<i>Gutierrezia sarothrae</i>	18 IX 1980	<i>Urophora</i>	2 (100)
	11 X 1982	<i>Urophora</i>	2 (100)
<i>Haplopappus acradenius</i>	8 XII 1983	<i>Neaspilota</i>	2 (67)
		<i>Urophora</i>	1 (33)
	28 XI 1984	<i>Trupanea</i>	8 (62)
		<i>Urophora</i>	5 (38)
	11 XII 1984	<i>Neaspilota</i>	1 (14)
		<i>Urophora</i>	6 (86)
<i>H. cuneatus</i>	16 X 1980	<i>Tephritis</i>	33 (72)
		<i>Trupanea</i>	4 (9)
		<i>Urophora</i> (2)	8 (17), 1 (2)
<i>H. laricifolius</i>	21 X 1982	<i>Neaspilota</i>	25 (63)
		<i>Urophora</i>	15 (37)
<i>H. squarrosus</i>	9 IX 1980	<i>Neaspilota</i>	13 (21)
		<i>Trupanea</i>	30 (48)
		<i>Urophora</i>	20 (32)
<i>H. venetus</i>	15 X 1980	<i>Trupanea</i>	3 (10)
		<i>Urophora</i>	26 (90)
	15 X 1980	<i>Tephritis</i>	1 (6)
		<i>Trupanea</i> (2)	8 (47), 2 (12)
	28 X 1981	<i>Urophora</i>	6 (35)
		<i>Trupanea</i> (2)	8 (32), 3 (12)
	8 X 1985	<i>Urophora</i>	14 (56)
<i>Trupanea</i>		2 (7)	
<i>Urophora</i>		28 (93)	

^a See text for complete rearing record for *Urophora*.

selection will be studied along with other aspects of the life history of this tephritid beginning in 1987. This species is especially suitable for a life history study among Neotropical *Urophora* because apparently no other species of Tephritidae infests the flow-

er heads of *G. hallii* (Table 1); whereas, as discussed below, the other species of *Urophora* commonly are synphagous with other genera of Tephritidae.

Urophora rufipes (Curran).—The single ♀ of *U. rufipes* reared from a small quantity

of flower heads of *Haplopappus acradenius* (Curran) prob. spp. *eremophilus* (Greene) Hall collected at Mountain Springs, SW Imperial Co., 8.xii.1983, represented the first host-plant record for this species (Wasbauer, 1972; Steyskal, 1979). Since then I have reared 4 ♂ and 2 ♀ and 4 ♂ and 1 ♀ from quantities of flower heads of *H. acradenius* collected along the south shore of Clark Dry Lake, SE San Diego Co., 11.xii.1984, and along the Coachella Canal above the thermal springs area, Riverside Co., 28.xi.1984, respectively. These also are the first California records of *U. rufipes*, known previously only from Arizona (Steyskal, 1979).

Urophora stenoparia Steyskal.—Similarly, 1 ♂ and 1 ♀ of *U. stenoparia* reared from a quantity of flower heads of *Gutierrezia sarothrae* collected at Pine Valley, Cleveland Nat. Forest, San Diego Co., 18.ix.1980, represented the first host-plant record for this species (Steyskal, 1979). I additionally have reared 3 ♂ and 1 ♀ from flower heads of *Gutierrezia microcephala* (deCandolle) Gray and 1 ♀ from the sample of flower heads of *H. cuneatus* Gray along with the 8 specimens of *U. timberlakei* Blanc and Foote reported below. I also swept 3 ♂ and 1 ♀ of *U. stenoparia* from *Hymenoclea salsola* Torrey and Gray during extensive field studies of the insect fauna of this common desert shrub (Goeden and Ricker, 1986a), which is *not* a host plant of this tephritid. Nineteen additional species of Tephritidae were swept from *H. salsola*, only one species of which infests the flower heads or otherwise reproduces on this common desert shrub (Goeden and Ricker, 1986, unpub. data).

Urophora timberlakei.—Wasbauer (1972) listed *Gutierrezia microcephala* (deCandolle) Gray as a host plant of *U. timberlakei*, and Steyskal (1979) cited this genus and *Chrysothamnus* as hosts. I have reared 10 ♂ and 7 ♀ of *U. timberlakei* from flower heads of *Acamptopappus shockleyi* Gray, collected at the SE end of Kingston

Mountains, NE San Bernardino Co., 27.v.1982; 2 ♂ and 1 ♀ from flower heads of *A. sphaerocephalus* (Harvey and Gray) Gray collected at Snow Creek, Riverside Co., 21.v.1982; 1 ♀ from flower heads of *C. nauseosus* (Pallas) Britton collected in Landers Meadow, Sequoia Nat. Forest, Kern Co., 3.ix.1981; 1 ♂ and 2 ♀ from flower heads of *C. teretifolius* (Durand and Hilgard) Hall collected in Westgard Pass, Inyo Nat. Forest, Inyo Co., 9.ix.1986; 31 ♂ and 42 ♀ and 3 ♂ and 3 ♀ from flower heads of *C. viscidiflorus* also collected in Landers Meadow on 3.ix.1981 and at Antelope Spring, NE Inyo Co., 15.ix.1982, respectively; 4 ♂ and 4 ♀ from flower heads of *Haplopappus cuneatus* collected in Lark Canyon, San Diego Co., 16.x.1980; and 8 ♂ and 7 ♀ from flower heads of *H. laricifolius* Gray, 1 km NW of Kessler Peak, S end of Ivanpah Mountains, NE San Bernardino Co., 21.x.1982. All my rearing records are for new host species. Two new host genera also are represented. The record for *G. microcephala* in Wasbauer (1972), originating from a host listing of R. H. Foote, but noted only as a sweep record by Blanc and Foote (1961) and Foote and Blanc (1963), still lacks confirmation and is suspect.

My field observations and rearing data suggest that all *Urophora* species native to southern California encountered to date are flower head-infesting, seed-feeding species, with the exception of *U. acuticornis*, which doubtfully belongs in the genus, judging from its distinctive host-plant affinities and attendant mode of development. Steyskal (1979) suggested that *U. acuticornis* likely will be referred to a distinct genus when more is known about American Myopitinae. Allen L. Norrbom (in litt. 1986) states that *U. acuticornis* not only is not a *Urophora* or myopitine, but rather is a trypetine.

I have detected no sign of galls on the excised compound inflorescences that mainly constituted the flower head samples

of *Chrysothamnus*, *Gutierrezia*, and *Haplopappus* reported above. Nor have I noted any enlarged flower heads in these and other host-plant genera mentioned in this report that are symptomatic of some other gallicolous Tephritidae, e.g. *Procecidochares* in *Chrysothamnus* (Table 1).

Of evolutionary and taxonomic significance is my observation that all of the confirmed host plants of the southern California *Urophora* mentioned in this report belong to the Subtribe Solidagininae of the Tribe Astereae (Munz and Keck, 1959). Thus, like so many Eurasian *Urophora* confined to hosts in the Tribe Cynareae, Subtribes Carduinae and Centaurinae, these southern California *Urophora* show a common affinity for a definable group of host plants in the Asteraceae (Zwölfer, 1965; Steyskal, 1979).

No life history of any Nearctic *Urophora* has been published. One difficulty involved is illustrated in Table 1. In southern California, at least, flower heads of *Urophora* host-plant species at most locations were commonly infested with other Tephritidae (synphagy). Genera commonly associated with *Urophora* are *Neaspilota*, *Tephritis*, and *Trupanea*. Rarely was more than one species of *Urophora* reared from a single sample. Associated genera differed qualitatively and quantitatively among some host-plant populations sampled, e.g. *Haplopappus acradentius* and *H. venetus* (Table 1). *Urophora* commonly were reared in small numbers and usually have been poorly represented in my sweep collections, reflecting, perhaps, their low population densities in nature. In some flower head samples, however, *Urophora* outnumbered at least one associated tephritid species; in *Chrysothamnus viscidiflorus*, overwhelmingly so (Table 1). Samples from two different species of *Acamp-topappus* appeared similarly composed. The undescribed *Urophora* apparently lacks tephritid competitors for heads of *Grindelia hallii*; whereas, *Gutierrezia* heads yield

another genus of Tephritidae, i.e. *Trupanea* (Goeden, 1985). Much remains to be learned about the host-plant relations of these and other Nearctic *Urophora*.

ACKNOWLEDGMENTS

My thanks to George Steyskal for his taxonomic help noted in the text, to Louis Blanc, Dick Foote and Al Norrbom for their reviews of early drafts of this paper, and to Don Ricker for his patience during stops to allow my many collecting forays.

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